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NEW GENERATION ELECTRICITY BOARD

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***Abstract* - Efficient energy consumption has become a need of time. Efforts in various fields are being made to reduce this power wastage. One of the leakage areas in the electricity distribution is the switch boards in every house. Though, it cannot be denied that transmission lines result in most electricity losses, the switch boards in every house also contribute in this. Also, the fault rectifications at the switch board stage can be done. Up till now, no significant efforts were done to optimize the consumption by modifications in electricity boards. This paper aims to highlight the shortcomings of the conventional electricity boards and the solutions to overcome them. The embedded controllers and power devices control the electricity consumption.**

Keywords—ARM Cortex M3 (lpc1768), Atmega 16, TSOP, TRIAC, Optocoupler and ZigBee.

I. INTRODUCTION

Since past few years the demand for electricity has increased exponentially. With the advancement in technology, different methods to harness the conventional energy sources have been developed. By keeping in mind the present energy usage, it takes no scholar to estimate that energy crises are eminent. So this is one of many attempts to avoid those crises. Electricity switch boards are the essential gateways for electricity from power grids to appliances. So, various solutions are currently being researched.

Electricity plays a vital role in daily life. It is one of the most important needs of human life. In India, 27% electricity of the generated electricity is getting wasted [5]. Out of which more than 50% wastage is due to human mistakes. We cannot generate electricity but we can save the amount of electricity getting wasted, as it is our national duty to avoid wastage and conserve electricity. There are many villages in India which are not getting electricity at all. There is a wide gap between the demand and supply of electricity.

Our nation cannot afford to waste the electricity. So, we came up with a solution to this problem by introducing automation in electricity boards. E.g. we can optimize speed of fan and light intensity depending upon the atmospheric conditions, smart mobile charging, etc.

We are proposing a system which will offer the convenience to everybody especially when doing something important, you don't need to walk over to the switch board and manually switch the regulator every time you wanted to increase or decrease the speed of fan. This paper seeks to develop a system that is cost effective while not under mining the need for efficiency.

TABLE I. Present Scenarios.

Sr. No.	Conventional Electricity Board	New Generation Electricity Board
1.	No optimized use of electricity.	Optimized use of electricity is possible.
2.	Passive components are used.	Active components are used. E.g. microcontroller.
3.	No automation.	Automation included.
4.	No centralized control. i.e. fully uncontrollable.	Centralized control for all rooms of house possible.

II. LITERATURE SURVEY

Some projects were made on controlling the electronic devices using microcontroller and circuits. Use of electronic circuit which can control intensity of lamp and speed of a fan using infrared TV remote is in[3] but they have not implemeted communication between the boards.

No closed loop system is in [4] to control the speed of fan. The systems which are developed up till now has no user

friendly keypad using which user can give instruction to board.

When TSOP 1738 (IR receiver) sensor is not used for IR remote, the effect of ambient light affects the input taken from remote [4].

III. METHODOLOGY

The architecture of this system includes multiple boards, which will be in different rooms. Living room will have master board and other rooms will have slave boards. (Refer to *Fig.1*) Master board will have centralized control over the slave boards. Every board of system will have 2 communication interfaces. One of them is for user to board and other is for board to board communication. User to board communication is done using IR remote control and board to board communication is done using ZigBee protocol (802.15.4).

Every board will have four features and they are- Smart Control over Devices, Speed Control of Fan, Light Intensity Control and Controlling Devices using Smart Modes. The 'Smart Control over Devices' facility will turn on the device for specified duration. For example water heater can be turned on or mobile can be charged for 30 minutes, etc. Fan speed and light intensity can be optimized by taking input from user through IR remote. These features are explained in detailed below:

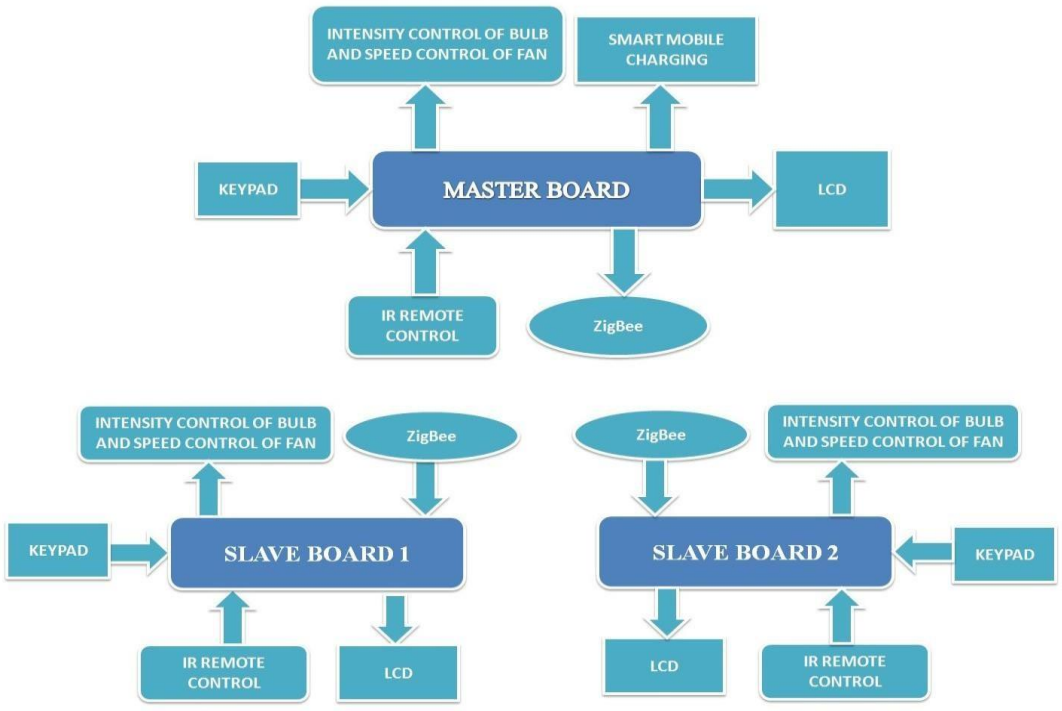

Fig. 1. Basic Architecture of System.

A. *Smart Control Over Devices:*

Sometimes we turn on the device and forget to turn it off. This leads to energy wastage. This point can be explained by two illustrations.

Consider, as we connect our charger and forget to take it off, the battery gets over charged. Overcharging adversely affects battery. It may also result in explosion.

Similarly, water heaters are not turned OFF even after the water has been heated to a required temperature. So, there are losses in electricity. In this feature the board will have keypad and LCD which are used for entering time and to display information, respectively.

User can provide the time using upward and downward arrows for incrementing and decrementing time. (Refer to fig.2) ENTER button is for selecting the time which is currently displayed on LCD.

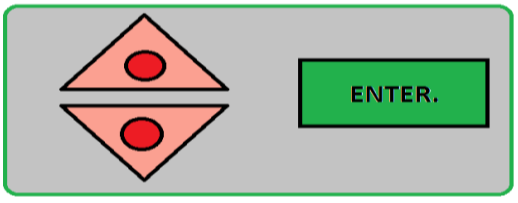

Fig. 2. Keypad

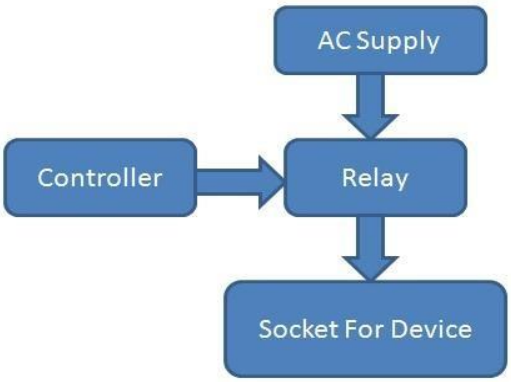

Fig. 3. Circuit for Smart Control Over devices.

Controller is driving the AC supply using relay. Using inbuilt timer of controller we can turn on a general purpose input output pin of controller, which is connected to the coil terminals of relay. Because of voltage at coil in relay the normally open terminal will become normally close and the AC supply will be switched over to the socket. At the same time controller will display remaining time on LCD. When the remaining time is zero, the general purpose input-output pin will be turned off and because of that the relay will turn off. In this way, 'Smart Control over Devices' can be provided.

B. Speed Control of Fan and Light Intensity control:

Many times we become lazy to walk over switch board and decrease the speed of fan or turn off the lamp. If remote is provided to control these things then more electricity can be saved. If we increase number of variations in speed of fan or light intensity of lamp, then user can set the speed or intensity according to his/her convenience. Electricity can be saved by providing this facility.

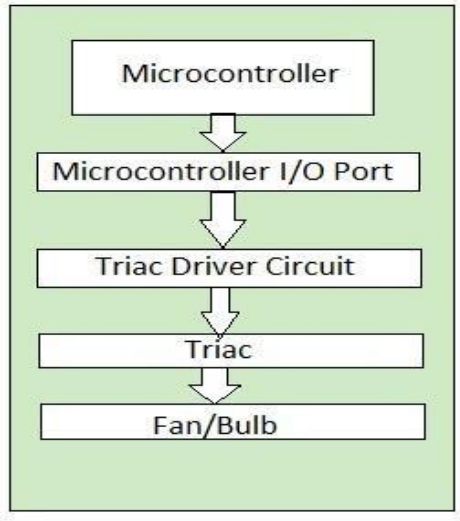

Fig. 4. Block Diagram of Speed Control of Fan and Intensity Control.

Speed control of fan and light intensity control will be done digitally using TRIAC, which has ability to control the voltage across main terminal 1 and main terminal 2.

Using IR remote user can change the speed of fan or light intensity of lamp. The pulses will be received by controller using TSOP. The data out pin of TSOP is connected to general purpose input output pin of microcontroller. Microcontroller will decide the duty cycle for controlling the voltage across TRIAC.

TSOP receives IR pulses and gives them to microcontroller. Microcontroller has facility to generate the pulse width modulation waveform with different duty cycles. If we change value of output control resistor in program, then the duty cycle will be changed, because of change in duty cycle the voltage across TRIAC will also changed. The output voltage at main terminal 1 and main terminal 2 is directly proportional to duty cycle of input pulse of TRIAC. Like this if the voltage is lesser across the TRIAC, the power loss will also be lesser. If we reduce the power loss, automatically electrical energy will be saved.

The TRIAC driver circuit has snubber circuit which contains resistor and capacitor. As we are connecting lamp as a load in series with AC supply, the load inductance produces damp and ringing. Basically snubber is placed across the TRIAC to suppress voltage spikes and damp. The snubber circuit removes ringing and high voltage spikes.

C. Controlling Devices Using Smart Modes:

There are seven modes for devices to operate on and they are:

a. 'All Devices ON' mode
b. 'All Devices OFF' mode
c. 'All Fans ON' mode
d. 'All Lights ON' mode
e. 'Dawn / Dusk' mode
f. 'Night' mode

IR remote will be provided to select a mode. User can select a mode according to his/her requirement. Modes of operation are explained in detail as follows:

- 'All Devices ON' mode:

In this mode microcontroller will turn on all devices using its general purpose input-output pins. All fans and all lights, chimney and fridge, TV will get triggered.

- 'All Devices OFF' mode:

In this mode microcontroller will turn off all devices using its general purpose input-output pins. All electronic devices will get turned off. This mode is very useful as we don't need to walk over every board and turn off the

devices. If we give instruction to master board it will forward that signal to slave boards using ZigBee and that instruction will be executed.

- 'Dawn' mode / 'Dusk' mode:

In morning or evening this mode can be turned on. As we have inbuilt timer facility in microcontroller, it can turn on chimney, water heater and lights in house for specified amount of time. Microcontroller will display the remaining time on LCD. When the remaining time will become zero, the devices will turn off. We can turn OFF any of the device using remote even before the remaining time elapses. The microcontroller will then follow the users' command and turn off the particular device.

- 'Night' mode:

This mode can be used during night. In this mode only fan, air conditioner or heater will be turned on. At the same time we can use 'Smart Control over Devices' facility provided by board.

IV. IMPLEMENTATION:

In this part we have explained about component selection for the system according to requirement. We have implemented smart mobile charging by using ATMEGA 16 which is used in slave board. Master board of the system is designed using ARM Cortex M3 and also implemented communication between boards using ZigBee.

A. ATMEGA 16:

It is a microcontroller with 32 general purpose input output pins and we are using it with DIP (Dual-In-line Package) package. As we need at least two 8-bit PWM (Pulse Width Modulation) for controlling voltage across TRIAC and one 16-bit timer for controlling relay. As we needed at least 16 general purpose input-output pins and some interrupts, we selected ATMEGA 16. As it is low cost device and fulfills slave board requirements, we selected it for slave board.

B. ARM Cortex M3:

This microcontroller have operating frequencies up to 120 MHz and have separate memory protection unit, it is suitable for master board. It has facility of ISP (In System Programming) and IAP (In Application Programming). As we have selected FTDI (Future Technology Devices International) for flashing the microcontroller using UART (Universal Asynchronous Receiver Transmitter) and ARM *Cortex* M3 has that serial communication facility.

Especially ARM has Ethernet interface, which can be used to implement Internet of Things and also we can implement multitasking by porting RTOS (Real Time Operating System) in it.

As ARM has 70 general purpose input-output pins and 4 general purpose timer/counters with 10 capture outputs and 8 capture inputs. It fulfills requirements of master board, so we have selected ARM *Cortex* M3 for master board.

C. ZigBee(Series 2):

For wireless communication between boards, we needed a device which can communicate over a long distance. ZigBee is 802.15.4 protocol which has many modules with different series and ranges. As the cost of ZigBee increases with its range of communication, we have selected Digi ZigBee series2 module which has outdoor range of 100 meters and indoor range of 30 meters.

For faster communication between boards, we need a module which has high data rate and ZigBee series 2 has data rates of up to 115 kbps. So we have selected ZigBee series 2.

V. RESULT

A. Energy saving in mobile charging and avoiding over charging of battery:

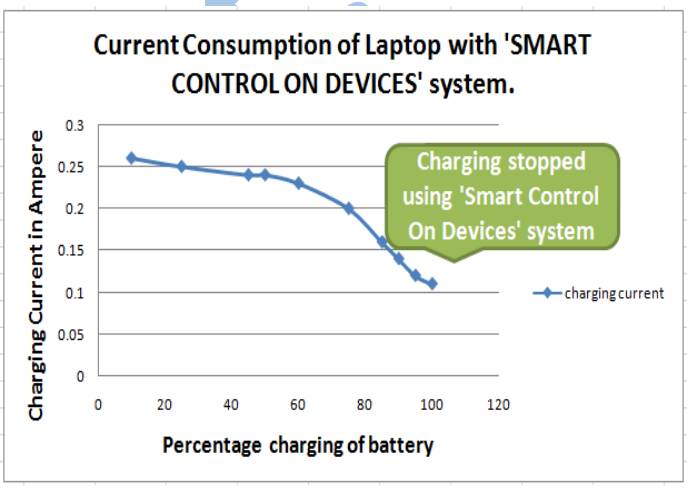

Fig.5. Effect of 'Smart Control On Devices' on current consumption.

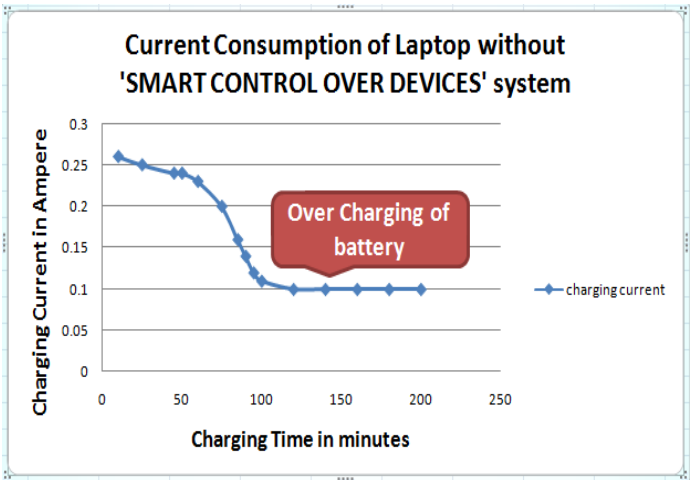

Fig.6. Effect of uncontrolled supply on current consumption.

As we know,

Power= Voltage * Current

We have, V=230 Volt,

From Fig.5 and Fig.6 we can say that Current consumed after full charging of battery is,

I=0.10 amp.

So, approximate power wastage is

Power = 230*0.10
=23 watt

According to calculations, we can save maximum 23 watt-hr energy which is wasted in each hour of Overcharging.

B. Range of ZigBee(Without Obstacle):*

TABLE III. Range of ZigBee (Without Obstacle).

Sr. No.	Master to slave distance	Communication established or not
1.	10 m	Yes
2.	30 m	Yes
3.	100 m	Yes
4.	120 m	No

C. Range of ZigBee(With Obstacle):*

TABLE IV. Range of ZigBee(With Obstacle*).

Sr. No.	Master to slave distance with number of walls	Communication established with distance
1.	Single wall	18 m
2.	Double wall	5 m
3.	More than 2 walls	2 m

(*Obstacle: Wall of thickness 30cm).

VI. CONCLUSION

We observed that, in a normal system, even after 100% charging of battery, it consumes power. Hence, we proposed this system so that power which is getting wasted can be saved using 'Smart Control Over devices'.

We also tested the same system on water heater and the difference observed is before using 'Smart Control over Devices' system, energy gets wasted due to human mistakes, but as we are switching off water heater after particular time energy gets saved.

As we have different modes of operation for all devices, the 'All Devices OFF' mode saves maximum energy. So, we came with the conclusion that energy can be saved by implementing 'New Generation Electricity Board'.

VII. FUTURESCOPE

Internet of Things can be implemented as a sub-part of this project. Using IoT, we can control appliances from the Internet. Maximum energy can be saved by using speed control of fan and intensity control of bulb.

By providing IR remote for communication with boards comfort can be increased.

Radio or any music facility can be provided built-in in the switch board.

VIII. REFERENCES

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